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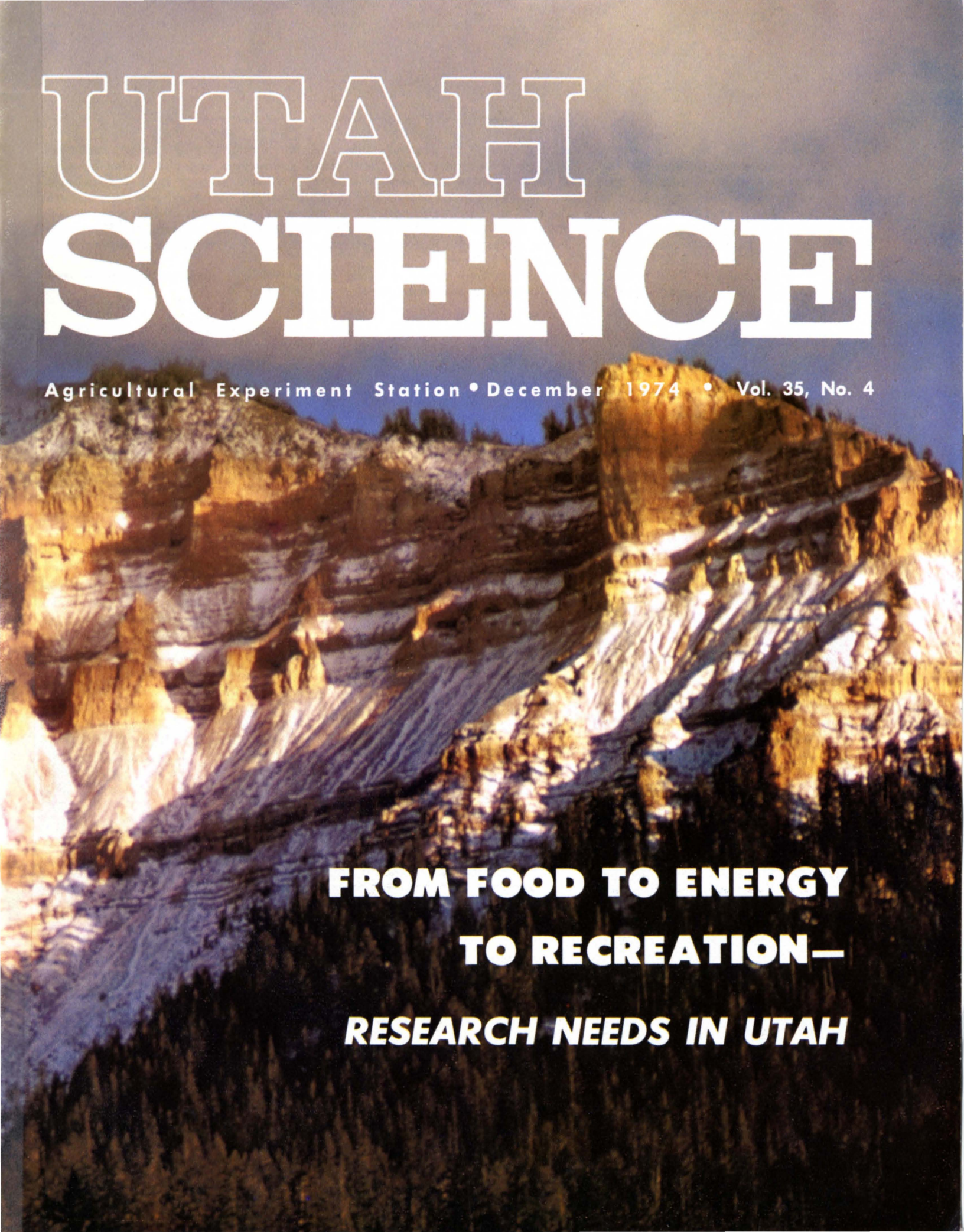

FROM FOOD TO ENERGY TO RECREATION—

RESEARCH NEEDS IN UTAH

Since 1888, the state's Agricultural Experiment Station has searched for methods to increase production and improve the quality of life in rural Utah. Over the years both food production and the problems connected with it have become more and more complex and demands on the Station's research staff and facilities have increased accordingly. In addition, new economic, social, and cultural factors connected with agriculture in Utah have greatly expanded the scope of staff participation. As of this date, there are approximately 100 Station researchers from 16 departments working on 130 agricultural related research projects. These projects range from studies on economic and social development of Utah communities through analyses of animal and milk production to basic research in biological systems.

In this issue of **Utah Science**, key staff members describe some of the Station's research programs and point out critical current and potential problems needing attention in the future.

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UTAH SCIENCE

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FOOD FOR CONSUMERS, A LIVING FOR PRODUCERS

DOYLE J. MATTHEWS

Will there be enough food? Roger Revelle, president of the American Association for the Advancement of Science, asks this question in a *Science* editorial appearing in the June 14, 1974, issue. He concludes:

> The United States has become the breadbasket of the world, in large part because of successful programs of research and application of research results. American agricultural researchers need to face an even greater future task — to use their methods and their insights to make possible a vast increase in food and fiber production throughout the world. In meeting this challenge they need reinforcement from the entire scientific community.

The present world food crisis began in 1973 when world food supplies declined about 2 percent, with per capita food available declining about 4 percent. World grain supplies declined that year for the first time in 20 years. Bad weather, rising incomes, inflation, devaluation of the dollar, international shipments of grain, and a world wide improvement in education about nutrition has caused unprecedented demand for United States food at a time of sagging supply. The resulting high prices coupled with shortages of fuel, fertilizers, and pesticides leave much of the world in a precarious situation.

It seems difficult to believe that just three short years ago many in America were bemoaning agricultural surpluses, condemning the subsidies that made them and the attending low consumer prices possible, and were talking of reducing public support for research and extension programs which have underpinned the total agricultural developments in the United States from the beginning. But at that time, lack of foresight was a common affliction.

It is now urgent that agricultural production be increased. New breakthroughs in techniques and methods are needed. New marketing methods which permit the producer to participate in the higher consumer prices for his product are required if an incentive to produce is to stimulate the supply.

Agricultural research at Utah State University hopes to contribute to a greater supply of agricultural products in general, to ease consumer concern about prices on these products, and at the same time develop ways for the producer to realize fair profits.

I would like to cite some examples of the present agricultural research effort which, in my opinion, demonstrates that we accept the dual challenge from consumers and producers alike.

SAVING FRUIT TREES FROM FROST

Since the beginning of recorded history in Utah, spring frost has played havoc with the well-laid plans of food producers. In recent years about 3 out of 5 fruit crops have suffered major to almost total loss due to untimely spring frosts. In

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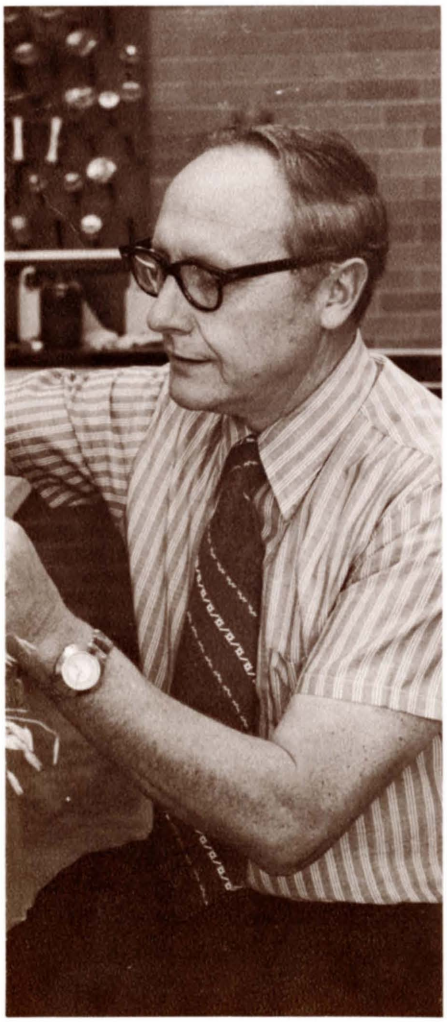


Doyle J. Matthews, dean of the College of Agriculture and director of the Agricultural Experiment Station

Almost the entire Utah wheat acreage is now seeded to varieties developed by scientists at the Utah Station.

1971, Governor Rampton pronounced the then current fruit disaster as intolerable and helped get Four Corners Commission support to augment Utah Agriculture Station funds in researching frost problems in an effort to overcome them. A project which combines studies of climatology, tree physiology, and mechanical means of protection has already produced a method of holding trees dormant through sprinkling and evaporative cooling until the most dangerous frost season is over. The project has discovered a whole new area of knowledge concerned with the accumulative effect of heat units and chill units in triggering the various physiological phenomena such as dormancy and blooming. This breakthrough has attracted wide national and international attention. Hopefully, the result will be a greater, more consistent supply for consumers and a more reliable, efficient enterprise for producers.

WHEAT DISEASE

A prime example of Utah Agricultural Experiment Station projects which accept the dual challenge of consumers and producers is the wheat breeding project. Only shortly after wheat was introduced in this area, a fungus known as dwarf smut attacked it. Smut, a highly adaptable organism, soon wipes out certain varieties of wheat unless someone stays ahead of it by breeding resistance into new varieties. These varieties have flowed from the Station with regularity starting with Relief in 1927, the first variety showing resistance to dwarf smut, followed by Cache, Wasatch, Delmar, and Bridger. As the smut organism adapted to each of these, another more resistant variety has been ready to replace it. Two new varieties, Hansel and Cardon, are now being released with high (almost 100 percent) levels of smut resistance, but we know the smut will adapt and in 5 or 10 years we will need new varieties again. Almost the entire Utah wheat acreage is now seeded to varieties developed by scientists at the Utah Station. It would be interesting to know if Utah consumers realize the importance of our local milling and baking industries and what their plight would be without them. Farmers know their enterprises could face disaster without access to disease resistant varieties. Utah farmers cannot get the resistance they want from other wheat growing areas because the most virulent smut organism here is quite specific to this state.

UTAH'S TURKEY INDUSTRY

The Utah Station at USU has played a significant role in establishing the multi-million dollar turkey industry in Utah. The state now ranks among the top dozen states in the nation in turkey production, despite the problems associated with having to export about 95 percent of the finished product and import most feedstuffs. Station scientists discovered and popularized the idea of enriching the incubator atmosphere with supplemental oxygen. This has increased turkey hatchability by about 15 percent and has been adopted throughout the state, especially wherever high altitude hatching is done. Station scientists have given valuable help in nutrition and management problems through the years. Now with the unusually highs feed costs and a national market moving toward

new ideas in further processed turkey products, the Utah Agricultural Experiment Station scientists are devoting time in studying new, more economical diets for turkeys and have developed several new turkey food products. Turkey has graduated to everyday availability on market shelves in several new forms such as turkey fillets, turkey bacon, turkey ham, turkey frankfurters, and salami. Turkey jerky is the latest creation. Both the consumer and the industry will benefit from these developments.

I have cited only three of over 130 Utah Agricultural Experiment Station projects designed to help solve the food problem for consumers and to bring producers a more profitable enterprise. Some may think that these goals are antagonistic and indeed in the short run they may appear to relate negatively but in the long run they must be made compatible or we will all go hungry.

We at the Utah Station are proud of these and other projects. My only regret is that I cannot discuss each of them with every Utahn. If you have an interest, come to Logan and let us show you our programs.

GOALS FOR UTAH AGRICULTURE

D. WYNNE THORNE

D. Wynne Thorne, former director of the Agricultural Experiment Station

Never has the world depended so much on United States agriculture as it does today. Rising populations, drought, and increased affluence in many nations are expanding demands for food beyond available supplies. One-fourth of our nation's harvest is being exported, accounting for 60 percent of the surplus food in world trade. Still, there is widespread hunger.

The situation can be summarized in a few brief statements. The green revolution itself has not failed. Rather, the increased harvests from new crops and fertilizer have done well to fend off disaster in the face of drought, floods, and the 2.5 percent population increase per year in developing countries. Even so, 1.5 billion people suffer from malnutrition, while hunger is the constant companion of at least a third of the world's population. At the same time some European nations, Japan, Taiwan, and the oil-rich Arab countries have become wealthy and their people want more meat in their diets. Consequently, world competition for food and feed grains has created spiraling food costs. Our reserve stocks of grain and other foods have been reduced to the lowest point in twenty years. The 60 million acres

Instead of profiting from the higher prices for agricultural produce our farmers are again trapped in a tight cost/price squeeze.

of United States land retired from cropping in the 1950s and 1960s as a result of thirty years of increasing yields have all been planted again. But costs of machinery, gas, fertilizers, pesticides, and other materials required by farmers have increased. Instead of profiting from the higher prices for agricultural produce our farmers are again trapped in a tight cost/price squeeze.

The failure of the world population conference in Bucharest to gain commitments from developing countries to reduce their high birth rates essentially insures there will be no short range solution to the world food problem.

With the world critically dependent on U.S. agriculture our farmers are again, as in the World War II period, being urged to increase their production. Since most short-run production gains must come from increasing yields per acre, is it feasible for farmers to push yields beyond already high levels? Our hopes for the future depend on new discoveries that can be applied to farm conditions to increase productivity. Let us look at such developments in our recent past:

The farm tractor replaced the horse in the 1930s and 1940s. This freed land required to feed 25 million horses and mules.

Fertilizers came into extensive use in this same period and gained intensive use in the 1960s. Fertilizer use in Utah was limited until the mid 1940s.

New pesticides, insecticides, and herbicides have increased in number and use since the introduction of DDT in the late 1940s.

Hybrid corn, first discovered in 1917, came into extensive use in the Corn Belt in the 1930s and was developed for other areas in the 1940s and 1950s.

The first Utah variety of wheat, Relief, resistant to dwarf bunt smut, was released in 1927. This was followed in Utah by a succession of improved wheats and barleys.

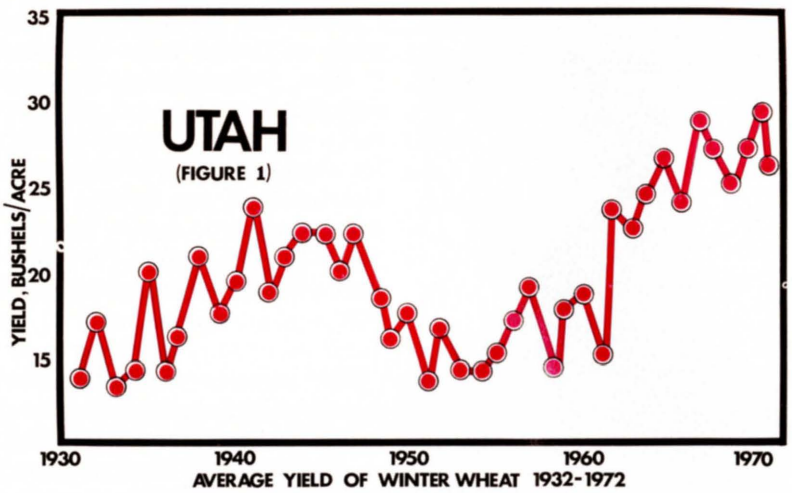
These few illustrations emphasize that the application of science to farming has been made mostly in the past 50 years. A primitive man transported to an American farm in 1920 would have felt modestly at home with farming practices then current, based on animal and human labor. But agriculture in this country today is one of the most dependent of all industries on science and technology. The close association of agricultural research extension and field production is often cited as a model for other industries.

The results of this collaboration have been dramatic. After centuries of fluctuating low crop yields and inefficient animal production, the gradual development and adoption of farm machinery, improved crop varieties, fertilizers, and pest control practices woven into systems of improved crop production have brought distinctive gains in crop yields and in animal productivity.

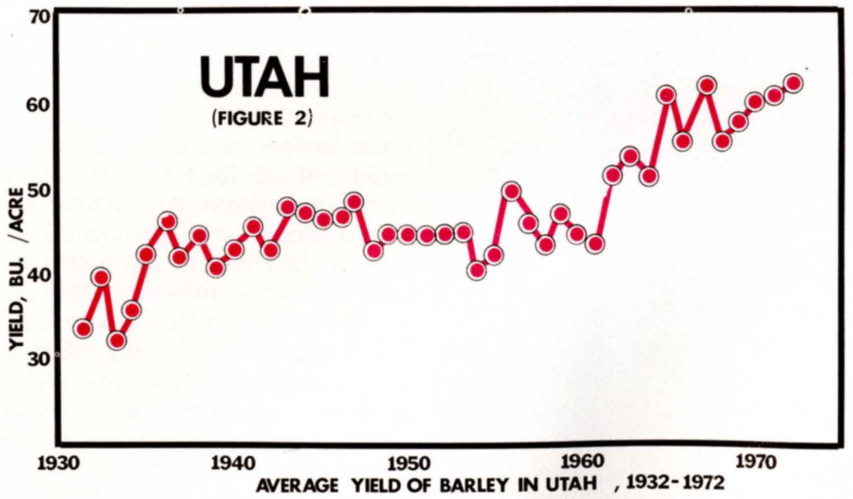
DOUBLE AND TRIPLE YIELDS

Figure 1, for instance, shows a doubling in the average yield of wheat. Since this crop in Utah is grown extensively under dry land farming conditions where moisture is constantly limiting, such gains are a tribute to the development and adoption of improved technologies. The general shape of the curve is related to the drought years in the early 1930s and in the late 1940s and early 1950s. The general upward trend is related to adoption of better varieties and farming practices.

Barley has also nearly doubled in average per acre yields (Figure 2). The current average of about 60 bushels per acre is one of the highest in the nation.



AVERAGE YIELD OF WINTER WHEAT 1932-1972



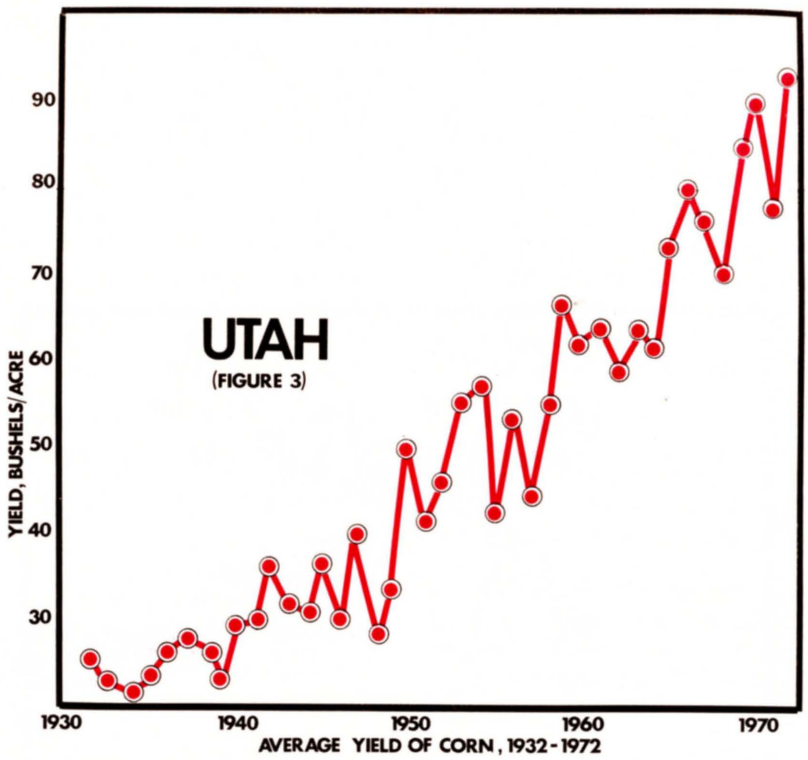
AVERAGE YIELD OF BARLEY IN UTAH , 1932-1972

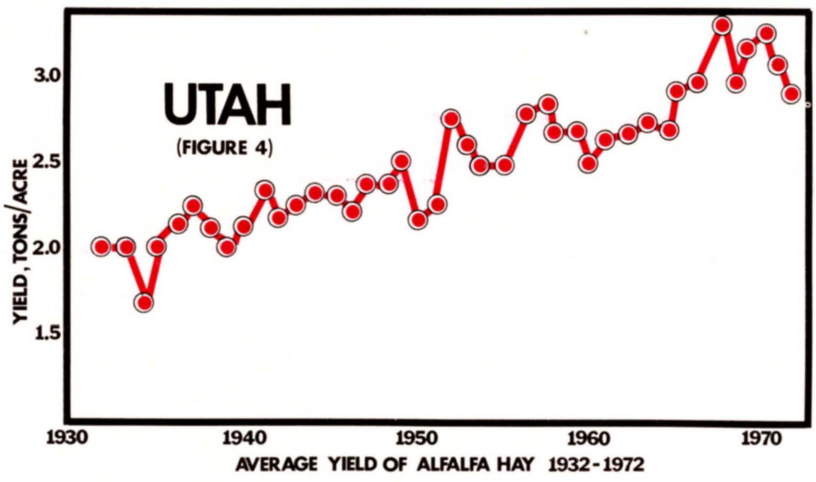
Corn for grain is the most dramatic story of all (Figure 3). The development and extensive use of high yielding hybrid varieties adapted to Utah's short growing season plus increased use of fertilizers and improved irrigation practices have resulted in average yields leaping from less than 25 to over 90 bushels per acre. Silage corn has also benefited. In consequence, corn acreage of the state has been increasing by almost 10,000 acres per year.

Alfalfa hay occupies nearly 40 percent of the harvested cropland of the state. Figure 4 shows a consistent gain in yields from an average of about 2 tons in 1930 to about 3 tons now.

Livestock has shown similar gains in productivity to that of field crops, although detailed statistics are lacking. Figure 5 resulted after taking all livestock and livestock products produced in Utah in the 1935-39 period and giving this average production for the base period (1935-39) to obtain a yearly index. The results plotted in Figure 5 reveal livestock production increased from an index value of 90 in the early 1930s to about 160 forty years later, or a gain of about 79 percent.

Gains in annual milk production per cow (Figure 6) have been almost as dramatic as gains in corn yields. Starting from a low base close to 5,000 lbs. per cow in 1930, production exceeded 11,000 lbs. per cow in 1972.





When such productivity trends are examined, the observer intuitively asks how long and how high such increases can continue. Surely there must be a limit. Is that point near? If so, what will this mean for the farmer? For the consumer?

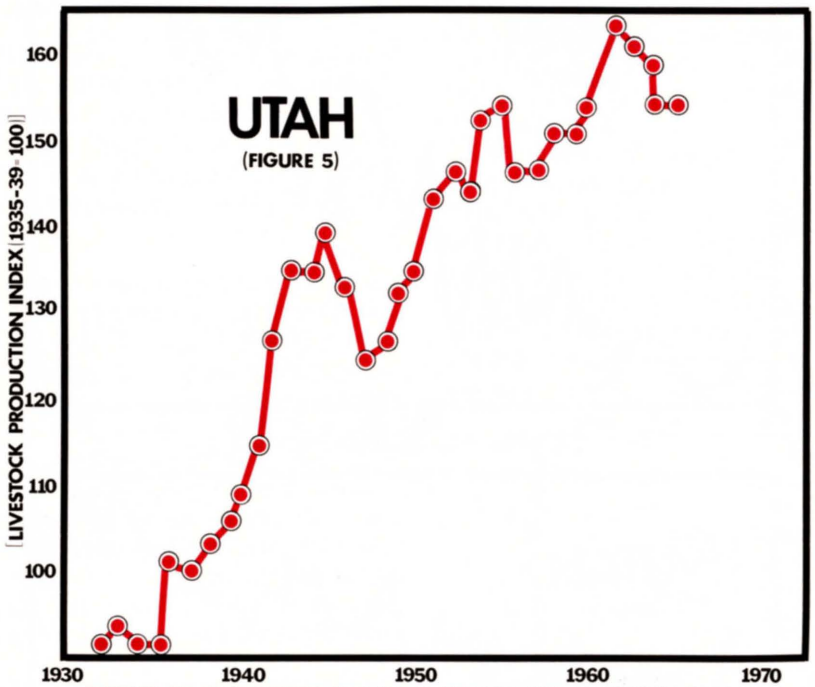
HOW MUCH PRODUCTION IS POSSIBLE

In hopes of finding clues to meaningful answers to such questions, I have examined yield and productivity data and have consulted with a number of USU's specialists in the crop and livestock fields. Together we have assembled some data comparing present yield levels, highest yield and production records, levels of production achieved by some of our best farmers, and our judgment as to a maximum goal for production on the irrigated farms of central and northern Utah. The resulting estimates are shown for field crops in Table 1, for dairy and beef cattle in Table 2, and for sheep in Table 3.

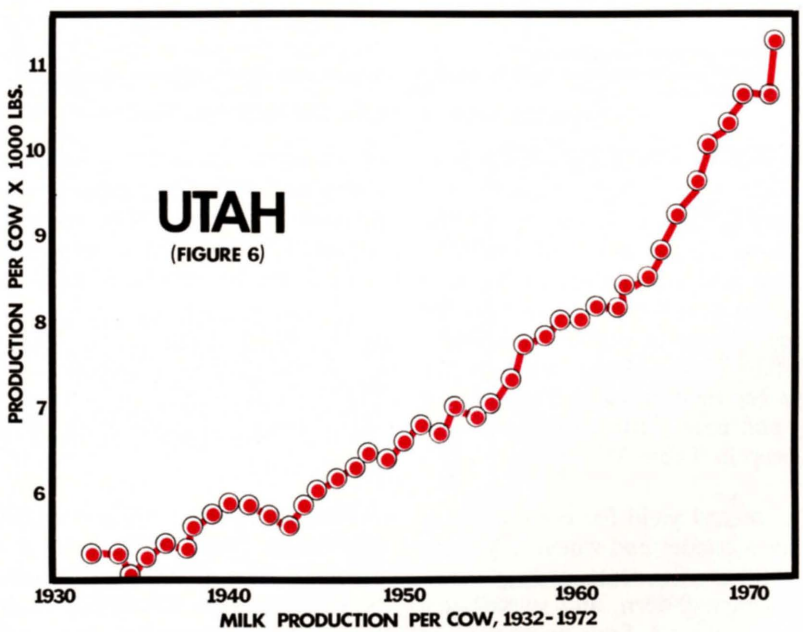
The record yield for corn silage is 2.3 times greater and wheat is 8 times greater than the state average. For alfalfa, barley, corn, and sugar beets the ratio is near 3. State average yield of winter wheat is exceptionally low compared with the record yield because a large proportion is grown on dry land farms and the suggested potentials are for irrigated lands.

Potential yields for our best farmers generally range from half to two-thirds of the record yields. Potential average yields for irrigated lands are generally one-half to one-third of the record yields.

Potential gains for livestock generally range from 20 percent to 100 percent. One of the most dramatic potential gains is a three-fold increase in the efficiency of use of human



INDICES OF PRODUCTION FOR ALL LIVESTOCK AND LIVESTOCK PRODUCTS, MEAT ANIMALS, AND MILK, 1932-1965



MILK PRODUCTION PER COW, 1932-1972

labor in milk production. This will require larger numbers of cows per farm and more efficient production systems and facilities.

Attainment of livestock goals will depend on research producing more effective controls for such diseases as calf scours, and other diseases associated with fertility reduction. Here the goals proposed for sheep are especially high, calling for more lambs per ewe and two lamb crops per year.

Although the goals presented are relatively long range for the majority of farmers and ranchers, we believe they are attainable by the best farmers with favorable soil, water supplies, and general production facilities. The average percentage production improvement over the past twenty years has ranged from 1.2 percent per year for the livestock index to 5 percent per year for corn grain. Should such current productivity improvement trends continue over the next ten years corn grain yields would then average 138 bushels per acre, alfalfa would have an average yield of 4.7 tons per acre, barley yields would average 72 bushels per acre, and milk production per cow would be 15,500 lbs. Continuation of most present rates of increase for an additional ten years seems quite feasible in view of the projected potential yields. However, maintaining high current increase rates for corn grain yields and milk production per cow may be overly optimistic.

As a practical measure, the Agricultural Experiment Station and the Extension Service propose developing a series of short-range goals, and providing recognition for producers who attain them. Detailed plans for this program and the short-range goals will be announced later.

But in the long run we must find new discoveries comparable in importance to hybrid corn, fertilizers, and mechanical power if crop yields are to advance much beyond the potentials indicated in the tables. Perhaps more realistically we must recognize that should currently debated policies on fertilizer and pesticide use

Table 1. Current and potential acre yields of crops

Crop	1972 Average Yields Utah	1972 Average Yields USA	Record Yields	Irrigated Utah Central Valleys Potential Best Farms	Irrigated Utah Central Valleys Potential Average Yields
Alfalfa, tons	2.85	2.88	9.1*	7.0	5.5
Barley, bu.	61.9	43.6	212.0	135.0	95.0
Corn, grain, bu.	92.0	96.9	304.0	180.0	160.0
Corn silage, tons	17.0	13.04	40.0	30.0	23.0
Winter wheat, bu.	26.5	34.0	216.0	110.0	90.0
Potatoes, cwt.	235.0	234.0	1400.0	600.0	450.0
Sugar beets, tons	19.6	21.2	54.0	32.0	23.0

*Central Utah, 3 crops.

Table 2. Current and potential performance characteristics of livestock*

Livestock	Utah	Potential
Dairy		
Milk production/cow/yr	11,730 lbs.	15,000 lbs.
Milk production/man/yr	350,000 lbs.	1 million lbs.
Calving interval	13.7 mo.	125 mo.
Services per conception	2.0	1.2
Calf losses	16%	5%
Cows on performance test	46%	75%
Beef		
Calf crop	70%	90%
Loss of calves	15%	5%
Weaning weight	425 lbs	475 lbs
Animals on performance test	1%	25%

*Estimate by Dean Plowman

Table 3. Estimated present potential production figures for sheep.*

	Range Present	Range Optimal or Potential	Farm Present	Farm Optimal or Potential
Age at 1st lambing (yrs)	2	1	1-2	1
Ewes lambing (2 yrs & older (%)	93	98	95	98
Lambing rate (%)	95	180	127	200
Weaning rate (%)	82	175	120	195
Weaning weight (kg)	36	44	40	55
Lamb weaned/ewe/year (kg)	30	77	48	107
Lambing interval (mo)	12	12	12	6
Lambs born/ewe/year	.88	1.76	1.21	3.92
Lambs weaned/ewe/weaning (kg)	30	77	48	214
Slaughter weight of lambs	43	68	45	68

*Estimate by Warren Foote

greatly restrict their availability and should excessive controls be placed on use of hormones and other medical supplies for livestock, Utah agriculture would be hard pressed to attain the indicated goals.

There is only a reasonable hope, but no guarantee, that such discoveries will be realized. Among the promising concepts being researched here at USU and elsewhere and on which our hopes in part depend are the following:

1. New plant varieties capable of utilizing a substantially greater proportion of sunlight energy than the current average of one percent.

2. New crop varieties that lose less substance and energy through photorespiration. These plants would have a metabolism similar to corn and sugar cane.

3. New nonlegume plants that have the capability of biological nitrogen fixation similar to that of alfalfa, and which would require little or no nitrogen fertilizer.

4. Development of new growth regulators that will cause plants or animals to direct more of their substance to tissues useful to man, such as proteins, seeds, sugars, or milk.

5. Development of new techniques for breeding plants without recourse to sexual reproduction. This will speed up breeding programs and make possible the production of new plant species from two parents that are only distantly related. This would open doors for new types of crops and better ways to control insects and diseases.

6. Utilization of a higher percentage of the growing season through new seeds that germinate at lower temperatures, through plants that grow actively during more of the season and through the production of more crops in the growing season.

7. Development of controls for calf scours through improved diagnosis and vaccines. This could save 10 percent of the calf crop.

8. Use of hormones to improve the conception rate of cattle and sheep and to increase the proportion of multiple births.

9. Greater use of relatively inexpensive protein substitutes in livestock feed such as ammonia, urea, and phosphate minerals. Silage treated with ammonia is giving excellent results with beef cattle and dairy cows.

10. Changed nutrition of cattle to increase the use of roughages in place of grain concentrates. High proportions of grains in feeds for beef and dairy cattle negate the natural advantages of their digestive rumen.

11. More selected cross breeding of cattle and sheep to increase efficiency and rate of growth of offspring.

12. Development of immunity to diseases in calves before birth so that a large number of early calf diseases can be avoided or at least greatly reduced.

While many of the above areas of research may be ten years or more away from field application there are innumerable small improvements that can be made in the meantime in crop and livestock production. Many of these consist of better use of information already available. These opportunities for crops include use of superior crop varieties and certified seed of these varieties; improved seedbed and planting practices; use of the proper combinations and quantities of fertilizer; better control of weeds, insects and diseases; improved irrigation practices; and harvesting at strategic times with properly conditioned equipment.

Similarly, increased livestock production will result from better sanitation around the feed yards and sheds, improved design of feeds using computer programs, improved management of large groups of cattle, and the joint planning of livestock operations and feed production practices to make the most efficient use of land and water resources.

The art of doing all things well and in the best combinations is the heart of successful farming. Farmers often joke about not needing more information because they already know so much more than they do. But such rationalization has a hollow, defeatest sound. Agricultural products are needed and the rewards from being a farmer come from doing the job well.

The art of doing all things well and in the best combinations is the heart of successful farming.

AG RESEARCH— In the College of Engineering

E. J. MIDDLEBROOKS

A significant proportion of the research effort in the College of Engineering has been shifted in the past two years towards projects concerning environmental quality, irrigation return flows, and energy as it relates to water in agriculture. All of these items are of current interest and the majority of the projects looking at specific problems were started long before the present popularity of environment and energy control.

Although less than 5 percent of the College of Engineering's agricultural-related research budget is received from state funds, the resulting research is directed toward solving agricultural problems specific to the state of Utah. In addition to the direct economic and scientific benefits of the nonstate-supported research effort, these funds bring in over 50 highly technical people capable of solving specialized problems that frequently occur. Many of the people in the state of Utah are continually contacting the College of Engineering for answers to specific questions which could not be answered were it not for the expertise brought to the campus by outside funds.

WATER MANAGEMENT

The College of Engineering has been intimately involved in the water management component of agriculture and the interactions of return flows with the other uses of water. Surface irrigation projects have been reoriented toward improving the efficiency of water management so that the quality of the return flows will be improved. Better management will also provide more water from limited supplies.

The Department of Agricultural and Irrigation Engineering has had a $610,000 per year contract for the past five years to study water management for increased agricultural production. The interactions of water and fertilizer with crop material are being studied to obtain the information required for making the best decisions. Although the work is being done primarily in Latin America it has direct application to the agriculture of Utah.

Irrigation is the foundation of Utah's important agriculture industry. Even the optimum use of the state's range lands requires an irrigated land base. To some extent, the future of agriculture is being threatened by the energy developments (coal and oil shale) being planned and some hard decisions lie ahead.

Water management holds the key to other important Utah problems. The concern for the future of Great Salt Lake and especially the current problem of the high lake stage with migration of salt to its north arm are related to water management for agriculture. The diversion of more water for agriculture use will provide a critical water management tool for controlling the lake level. Evapotranspiration by agricultural crops in Utah ranges from about 16 inches (1.3 acre feet per acre) for grain to as much as 30 inches (2.5 acre feet per acre) for alfalfa. Reducing the fresh water entering the lake by increasing the agricultural diversions and consumptive use will probably be a better solution to the problem than the proposed withdrawal of salty water from the lake to some desert area for evaporation.

Although Utah State's College of Engineering has one of the world's outstanding programs in the field of water management, quality control, and planning, it has not been fully utilized in the state of Utah, especially with regard to the interactions

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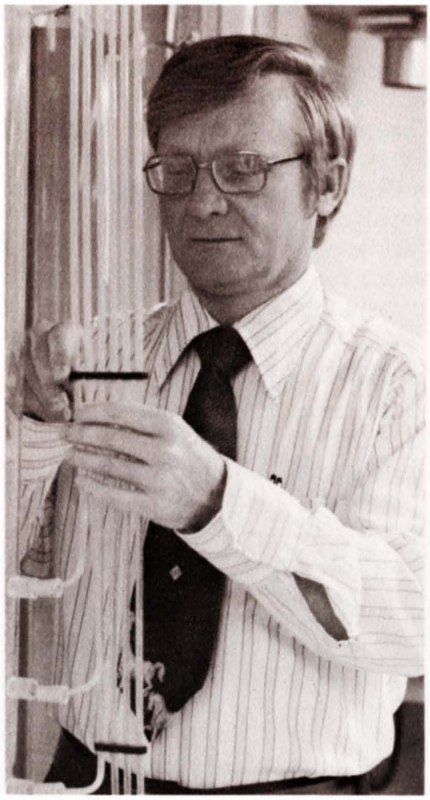


E. J. Middlebrooks, dean of the College of Engineering

of agricultural water use and industrial developments now being planned. For instance, many faculty members have international reputations in the areas of impact statements and long-range planning, but similar components of state government have not utilized these people.

FRUIT TREE BLOSSOM DELAY

One of the most significant individual contributions that the Department of Agricultural and Irrigation Engineering (in cooperation with plant and soil scientists) has made to the agricultural industry of the state of Utah is the discovery that overhead sprinkling will delay fruit bud development and reduce the risk of freeze damage to fruit trees. Other departments of the University are now collaborating in the study to fully understand the plant physiology and climatological factors involved. Previously, only economically marginal solutions were available to the fruit industry to control spring freeze crop damage — involving millions of dollars in losses seven years out of ten. With the recent world wide shortage of fuels, it is even less attractive to the farmers to use various types of heating to protect their fruit from spring freezes. The overhead sprinkling technique is a very low energy-using process, and in all probability will be the technique employed in the future to prevent fruit trees from early blossoming and reduce the probability of damage due to spring frosts.

FOOD, FIBER, AND ENERGY

The production of food and fiber in sufficient quantities to alleviate worldwide suffering will require vast amounts of energy. Solar energy is our largest and most pervasive source of energy and growing plants remain the only practical converters of solar to chemical energy on a large scale. Methods to utilize the photosynthetic process for the production of fuel as well as food and fertilizer are being devised in the College of Engineering. Two basic approaches are being followed: a) conversion of agricultural wastes to fuel, animal feed, and fertilizer; b) production of an energy crop to specifically provide fuel as well as food. Both approaches involve fermentation of organic materials followed by solar drying of the resulting biomass for optimum nutrient recovery.

WATER QUALITY

Studies of phosphate pollution and eutrophication, thermal pollution, toxicity to fish and microorganisms, organic compounds, stream and lake pollution, man's effects on mountain watersheds, and water quality models are only a few of the many areas of research dealing with the problem of pollution of Utah's high mountain streams and lakes where high quality water is found. All of the activities have the objective of solving the special problems of the Great Basin drainage and the Lower Colorado River Basin drainage where high agricultural water use, municipal-industrial pollution, and natural impact of polluting materials have lowered the quality of river and lake water.

Ongoing studies include an aeration project on Hyrum Reservoir to study the most economical means of restoring recreational quality to a lake with a gross eutrophication problem due to agriculture-caused inputs of nutrients. Future urban and industrial, as well as agricultural development, will increase the eutrophication of recreational reservoirs. restricting their uses to activities requiring only minimal quality. Economical, low maintenance methods of maintaining quality in reservoirs will become more important as needs for water increase.

Another important area of water quality research deals with diffuse sources; that is, water which becomes polluted and enters lakes and streams as overland flow rather than through specific pipes (point sources) as from a sewage treatment plant. Large scale energy and mineral extraction, agricultural activities, urban runoffs, and recreational uses all contribute to diffuse pollutant loads to lakes and streams. Several research projects on agricultural activities, oil shales, and recreational uses are in progress or anticipated concerning the effects of specific pollutants on beneficial uses

of water and/or the aquatic ecosystem itself.

WASTEWATER TREATMENT STUDIES

Anticipating the need for low-cost, low-maintenance methods of handling rural sources of wastewaters, several projects funded by the Environmental Protection Agency (EPA) are in progress on lagoon methods of waste treatment and irrigation with waste waters or land disposal of sewage wastes. Questions about removal of algae (microscopic aquatic plants), spray irrigation techniques, year-around operation of lagoons, effects of chlorination on disease potential, and on the aquatic ecosystem are all being studied. The results of this research will have significant effects in Utah as communities attempt to

meet state water quality standards.

In addition to these projects, other research on waste disposal methods are needed which fit Utah's particular needs. Such research needs significant input from the state of Utah in terms of matching and developmental funds.

PLANNING STUDIES

Planning studies on river basin water quality are presently in progress. These studies deal with competing uses of water within specific river basins and attempt to allocate in the best method possible the municipal, agricultural, and industrial-mineral uses of water while still maintaining adequate downstream quality.

Additional interdisciplinary planning studies on social-political-economic and legal effects of various water allocations are also in progress. These studies attempt to determine the effects of the various kinds of water uses and their effects on population growth and distribution, environmental quality, recreational potential, and similar aspects.

Quality of rural life is also being considered by the Occupational Health and Safety Program at USU where efforts are being made to eliminate or reduce accidents on the farm. Individual culinary water systems and waste disposal methods applicable to rural areas are also being developed and evaluated.

The College of Engineering will continue to serve the people of Utah. Its staff and programs are available for their use.

FAMILY AWARENESS

PHYLLIS R. SNOW

Research to improve the stability and quality of family life in Utah must solve actual, practical problems, deal with basic issues, and relate directly to human beings. Extension and resident teaching and research faculties must work together in planning, presenting, and evaluating research projects. It is upon this interrelationship of research and teaching that the College's research programs are based.

CHILDREN AND FAMILIES

All major personality theorists agree that the first two years of life are critical in establishing a foundation for a healthy personality. Yet most of the social interaction and communication during those two years is nonverbal and, unfortunately, we know almost nothing about prelinguistic human dynamics.

A longitudinal videotape study is underway in the College of Family Life to study parent-infant interaction as it unfolds in the normal home environment. Super slow-motion analysis of this film is expected to reveal the micro-interactions and communicative processes involved.

Family Life researchers are attempting to determine deficits in the areas of concept and language development among Head Start and kindergarten children and to design experiences intended to provide individualized learning to overcome these deficits.

The need for studies on human development and what it means to be male or female has been explored, programs in other states reviewed, and the findings incorporated into training programs for teachers in the elementary and secondary schools of Utah.

NUTRITION

Nutritionally inadequate food consumption still prevails among a high proportion of our people. The aged, the very young, and those with special needs, or with low incomes, are particularly vulnerable.

In the five-county area of southern Utah (Beaver, Iron, Garfield, Kane, and Washington), twenty Vista volunteers have designed a program in which research and implementation is combined to bring together the young and the elderly and mobilize the communities to solve their own problems of nutrition for the elderly.

Phyllis R. Snow, dean of the College of Family Life

Researchers are taking 3-day dietary recall and making body fluid analyses in order to determine present nutritional status and correlate this with improvements as the program progresses.

To facilitate analysis of the nutritional adequacy of our diets, researchers have developed an INDEX OF FOOD QUALITY (IFQ) based on energy needs and a concept of nutrient density. The index can be of inestimable value in evaluating food intake of individuals or populations in nutrition education programs.

One of the best entrees to research on the needs and way of life of low-income families is USU Extension's 10-county Expanded Nutrition and Food Education program for low-income families. Case studies abound which clearly show that nutrition and homemaking skills are much improved by it. The first programs moved so fast, however, there was not time to determine a preliminary base line state of health of the families. More care has been taken to include this factor in the last counties added so that University Extension can better evaluate the effectiveness of its teaching programs.

The College participates in two research and training grants for the development of its Medical Dietetics Program for the preparation of students to function successfully as clinical dietitians in beginning level positions in hospitals, metabolic research units, out-patient clinics, and community agencies. The Ogden McKay-Dee and Logan Latter-Day Saint hospitals and the USU Food Service have agreed to allow the use of their facilities to provide instruction.

Other research programs have shown that injections of contraceptive steroids increase retention of zinc and concentrate body calcium and cholesterol within the adrenals and ovaries, thus explaining some of the visible signs of the use of oral contraceptives. Also we've found that the published values for the iron content of foods do not indicate effectiveness of utilization and thus can be misleading. For example, 54 percent of the iron in hamburger and eggs is utilized in the production of hemoglobin as compared to 30 percent of the iron in whole wheat bread and 21 percent in enriched white bread.

Trace elements in nutrition are being restudied to explore the relationships between nutrition and some of our more resistant health problems. For example, it has been found that iron is needed for the production of hydrochloric acid in the stomach, and that the fluid is needed to make the calcium-phosphates of our foods soluble enough to be usable by the body. Since iron is the mineral most often lacking in the American diet, its lack over a long period of time may be directly related to the high incidence of osteoporosis in the elderly. The incidence of ulcers and excessive use of antiacids in turn may be related to osteoporosis.

Research is also underway using a fermentation process and/or organic acids with higher amounts of bone in processed deboned meat products to determine how a high pH of the meat affects added bone calcium availability and relates to consumer acceptability.

Adequacy of food storage by Utah families was explored. It seems that, regardless of purpose, families are not providing for calcium. Stored foods were evaluated against the Basic 4 Food Plan and the survey indicated that foods in the milk group, our best source of calcium, were not being stored.

THE CONSUMER

Resource management is especially critical in low-income families. An investigation into the needs and interests of low-income urban homemakers in Utah revealed that areas of most concern were food preparation, food purchase, health, and safety. Another need was observed, especially among Spanish speaking homemakers, for a consumer advocate who could be of assistance in cases of consumer exploitation or fraud where language problems make communication difficult.

Family Life researchers have developed a "body boundary" theory

which defines each individual as having a psychological body boundary that has little to do with the actual physical skin and influences greatly a consumer's choice of style and color of clothing.

Other researchers in the college are exploring the satisfactions to be achieved through recycled clothing, investigating the basic principles involved in remaking clothing, the costs, and the satisfactions derived, and investigating a theory of fitting which will allow "perfect fit" in clothing with less time required to perfect skills.

A college-designed kit for exploring space relationships, materials, and costs aids familes in designing for their specific needs when building new houses or remodeling old ones. The kit can be used by students, teachers, and extension agents as they learn about housing needs and discuss their findings with families. Builders and architects can also profit by the information provided.

A project to explore individualized study as a way of teaching was applied to the teaching of concepts of self by high school students and to a basic clothing construction class at the college level. Satisfaction with the classes and increased enrollment have greatly increased as a result.

In the College we have a firm conviction that education for family living can no longer be for women alone. Thus a new research project was undertaken, financed by the State Department of Education, to aid in the intergration of men into the consumer and home economics education programs of the secondary schools throughout Utah.

With rising costs of all education, research was undertaken to determine guidelines for budgeting for food programs in the secondary schools of Utah, and to suggest buying procedures which would minimize costs. The study found, among other things, that it is not necessarily cheaper to purchase food at a large chain store as compared to a small local store.

FUTURE RESEARCH

Since 75 percent of our communities have populations of less than one thousand and 75 percent of the state's population is concentrated along the Wasatch front, Utah can provide data both on urban and rural life styles, and the problems related to each. For instance, how does schooling, home life, and personality development differ in the urban and rural settings?

With a fairly large and separate American Indian population, and a need for building cross-cultural bridges, Utah is a ready-made laboratory for cross-ethnic, cross-cultural research. In fact, a project is underway in the College to explore the effects on both Indian and white families as Indian children are placed in white foster homes while they attend school off the reservation during their formative years.

As a result of previous research in childcare and family relations our two largest classes, "Human Development" and "Marriage," focus on parent and family training. Research now needs to be done to assess the appropriateness of the curriculum, the effectiveness of the teaching techniques used, and the long-run effect of our teaching on the quality of family life for those who have taken the courses and now have homes of their own.

Day care is expanding in Utah. Because of the high capital costs of large units, small day care units providing for one to six children in the operator's home, is increasing. The experience of those who license and supervise family day care in Utah suggests that there is a real need for educational services and improvement in quality of this type of service through development of model training programs.

Studies are also needed to determine the effects of nutrition on school performance by combining systematic evaluation of children's nutritional status with newly developed, objective techniques for analyzing classroom behavior.

Problems of quality of living are not easily solved. They require the help of many people and vast array of expertise. They require time. But most of all, they require the support of the people of Utah.

UTAH—

AND THE NATION'S NEEDS

THADIS W. BOX

Utah and its sister states in the Rocky Mountain West are facing a growth in resource exploitation that may alter the western way of life. In the light of increasing demands, and in some cases shortages, of energy, water, recreation, and red meat and the location of many such resources in the West, we could well become a "national sacrifice area" as suggested by a recent National Academy of Sciences report.

But there is also great promise of economic development for Utah if the national demands are met and this has generated many questions by Utah citizens. What will Utah gain from resource development? Will the lure of jobs for our children lead us into development that will cause destruction of our western environment? Can we avoid being a sacrifice area? Can we have development and a healthy environment? As a land grant university, one of our first responsibilities is to anticipate problems and initiate research to help solve them before they become acute. I would

Utah will have a special role in the short, medium, and long term supply of energy.

Water is the limiting resource in any arid land.

Thadis W. Box, dean of the College of Natural Resources

like to discuss four areas where special demands will be placed on Utah's resources and discuss what the College of Natural Resources is doing in research to help solve some of the problems that may result from them.

UTAH'S ENERGY

Utah will have a special role in the short, medium, and long term supply of energy. Oil and natural gas are flowing from several fields and exploration continues. Water power generates electricity through hydroelectric plants on streams throughout the state. Almost 18 percent of the state is underlain with coal — most of it of the low sulfur kind that is in high demand. Billions of barrels of oil are locked in the Green River shale and two of the four authorized pilot plants for shale oil extraction will be in Utah. Utah has long been a major producer of uranium. Exploration is proceeding at a rapid pace, being spurred on by promising geological features. Large known areas of geothermal activity exist in Utah and pilot plants are planned to tap them.

There is no doubt that Utah will develop some, if not all, of these sources as the nation tries for energy self-sufficiency. Some important questions associated with this development deal with the impact of development on the environment and ways and means of mitigating its undesirable effects.

Faculty members in natural resources have several research projects in the energy area: studies on a regional energy framework; on endangered fish and wildlife, the effects of dams on fish populations, and other environmental matters; on the effects of surface mining and rehabilitation techniques; and on the development of plants, especially shrubs, tolerant of disturbed soils.

This is just an indication of the research needed if Utah's energy resource is to be developed. If current knowledge is properly applied and an accelerated research program funded, many of Utah's energy resources can be developed with minimum adverse effects on the state's environment.

UTAH'S WATER

It's necessary, however, to look at energy exploitation in relationship to other resources, especially the water resource. Water is the limiting resource in any arid land. A study recently released by the United States Department of the Interior states that Utah's water resources are already overcommitted and that major shifts in allocations will have to occur if energy development is to proceed at the rate suggested in Project Independence. Where will this water come from?

New reservoirs and impoundments will have to be developed if the water presumed to be available is to be actually used. In addition, water will have to be reallocated. The report suggests that agriculture will lose water in any reallocation. Many problems are inherent in this development and reallocation which departments in the College are now examining: the effects of forest and grazing practices, fires, and similar processes on water supply and distribution; effects of stream diversion on fish populations, including endangered species; and sources and effects of salt on the quality of water in Utah's streams.

But the problems relating to the use of Utah's life sustaining water far exceed funds to solve them, and this list could go on and on.

UTAH AS A RECREATION SOURCE

The influx of nonresident recreationists forms the basis for one of Utah's major sources of outside dollars — the tourist industry. The evaluation of impact of tourism on local communities and its role in rural development is a major goal of both research and extension efforts.

Recreation areas, like cattle ranches, have a definite carrying capacity.

Recreational areas, just as cattle ranches, have a definite carrying capacity. When the capacity is exceeded, the resource deteriorates and profits decrease. Several projects in the College are directed toward determining the proper carrying capacity of recreation areas ranging from wilderness and scenic rivers to highly developed campgrounds.

Utah has traditionally been one of the major hunting and fishing states in the West. As population pressures increase, the chance of bagging a limit decreases even if there are as many or more wild animals than in the past. Research projects on big game, upland game birds, waterfowl, and fish are attempting to find ways to increase hunter success and accommodate more people in Utah's outdoors.

With the influx of more people into the state, recreational opportunities for Utah's city dwellers and small town people alike will need outlets. Projects dealing with the use of irrigation canals, bikeways, horseback trails, and similar recreation opportunities for local people are planned or currently underway.

Utah's reputation as a winter sports area is increasing rapidly. The quality of its snow has caused a number of new ski areas to develop and more are planned. Researchers at Utah State are attempting to analyze these new industries and give guidance to their growth.

Conflicts involving off-road vehicle use in ranching areas may decrease food production. These conflicts need to be resolved if Utah is to meet its challenge in producing red meat. Unless we increase research into the orderly development of Utah's recreation industry, it too can lead to destruction of our western way of life.

UTAH'S RED MEAT PRODUCTION

A recent report by the U.S. Department of Agriculture estimates that our nation needs the equivalent of 14 million head of brood cows by 1980 to meet the nation's demand for red meat. They predict that these animals will be grown on forage from marginal cropland.

Unfortunately, that marginal cropland may not be available for growing cattle. The high price of grain and predicted world shortages of grain for human consumption have caused these lands to be put into grain production. At the same time, high feed costs and a fickle beef market are causing beef production in feedlots to be an extremely risky business.

All these factors point to an increasing demand on rangelands to produce meat — not only feeder livestock but animals that can go directly to slaughter. These indications have caused our college to intensify its efforts in range management research and develop new projects in increased animal production. Some of these are aimed at protection of plants and animals. For instance, research on black grass bug control is designed to prevent damage on wheatgrass; predator research is aimed at evaluating and preventing animal loss due to predators. An ambitious new program in range management is underway in the College with the cooperation of the state Department of Agriculture and

A strong effort to increase range production will help our economy and add to the badly needed protein food supply of our nation.

the Extension service. Range nutrition research is aimed at increasing efficiency of animal performance on the dry rangelands of Utah. Range economics projects attempt to increase overall production efficiency.

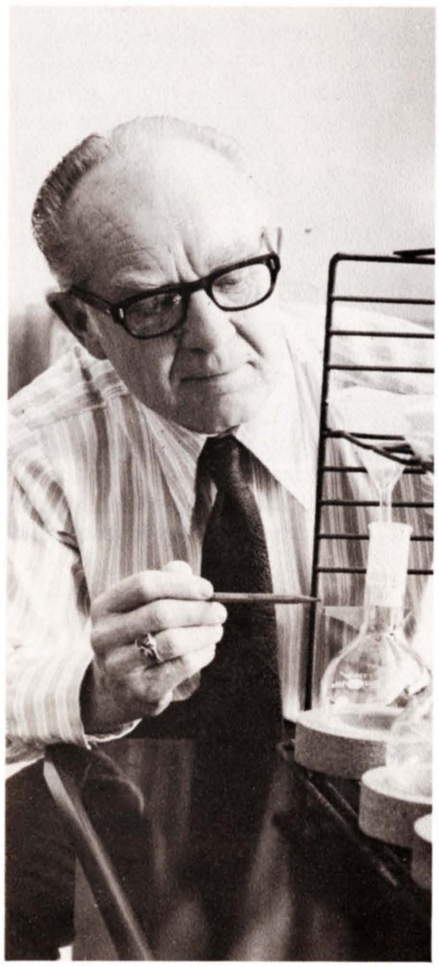
This is only part of the research needed if Utah is to increase red meat production from her rangelands. I believe that a strong effort to increase range production would help our economy and add to the badly needed protein food supply of our nation.

FUTURE DIRECTIONS

Utah State has a long history of agricultural and natural resource research designed to solve the real day-to-day problems of Utah's citizens. And while we'll continue to serve the traditional industries with basic and applied research for fruit, timber, crop, dairy, and poultry production, new problems continue to develop in the oldest of industries and the research job is never done. More use will be made of research going on in surrounding states and a special effort will be made to complement rather than duplicate this work. For instance, we do no work in wood technology and little in timber production. We look to Washington and Oregon for these. We work on pinon-juniper management, water production from dry timber sites, and similar projects and hope our research will not only assist Utah, but be of value to eastern Washington and Oregon.

We are also trying to anticipate the major new areas where little or no research data exist and develop partial answers to problems that are sure to arise.

I have attempted to highlight four problems that I think will have a special and unique impact on Utah in the next decade: energy, water, recreation, red meat. Any one of these represents a needed major increase in research funds and manpower. All are related and together they form an almost insurmountable opportunity for a land grant university such as ours. Fortunately, Utah State has a cadre of well trained professional research people with a good track record of rising to public need. Utah, though not an affluent state, has a good record of supporting research designed to improve conditions in the state. Although the task is great, I am optimistic about our chances of serving the nation's needs, increasing our economic position, and preventing major destruction of our western environment.



Ralph M. Johnson, dean of the College of Science

THE IMPORTANCE OF BASIC RESEARCH

RALPH M. JOHNSON

"It is also the intent of Congress to assure agriculture a position in research equal to that of industry, which will aid in maintaining an equitable balance between agriculture and other segments of our economy. It shall be the object and duty of the State Agricultural Experiment Stations through the expenditure of the appropriations hereinafter authorized to conduct original and other researches, investigations, and experi-

As many as ten or fifteen years may elapse between basic research and its ultimate application in the field.

ments bearing directly on and contributing to the establishment and maintenance of a permanent and effective industry of the United States, . . ."

The above is quoted from Section 2 of the Hatch Act of 1955. The productivity of American farms is a direct result of the incorporation of research findings into the farming operation. Irrigation, crop rotation, pest management, fertilization, soil management, hybridization and breeding practice, animal nutrition, and animal management practice, are but a few of the areas where experiment station research has contributed directly to "The Miracle of American Agriculture," and established the basis for agriculture as an effective industry of the United States.

Countless in-field studies attempted to discover the best way to farm. Much of experiment station research was recognized to be of an applied nature, and station research projects were initiated in response to recognized problems — the development of a new or improved piece of farm machinery, the effective and economic eradication of a noxious weed, or the production of a disease resistant plant variety.

BASIC VERSUS APPLIED RESEARCH

Basic research involves studies conducted with no specific applied problem in mind, but rather the attainment of new information, the discovery of new principles, or the further elucidation of natural law that would direct future research. As many as ten or fifteen years may elapse between this important work and its ultimate application in the field. While extensive improvements were taking place in our agricultural industry through largely applied research programs, significant developments were occurring in the area of basic research that would be of significance in determining much agricultural research in the future.

Whether worked into applied research or inspired by questions originating with the applied research effort, much basic research has been carried on by experiment stations throughout their history — research in such areas as energy utilization mechanisms by the animal, the roles and utilization of several vitamins by the animal, plant hormones, the biochemical nature of several nutritional deficiencies, and the etiology of certain anemias.

These developments have been accompanied by the accumulation of extensive biological information coming from nonagricultural related or supported basic research. It is information that is vital to the understanding and further study of agricultural problems, and its very existence must exert considerable and probably increasing influence on the nature of the work undertaken under future agricultural research support.

FROM THE ORGANISM TO THE CELL

Old distinctions between the biological and physical sciences have all but disappeared in many instances. Emphasis within biology itself has shifted from the total organism to the cell. Geneticists now are directing their research to the underlying genetic mechanisms; for instance, in the action of herbicides and pesticides. Research in viral action, in the immunity toward viruses, in protein replication, and in a host of related areas has revealed new and powerful research tools in agriculture.

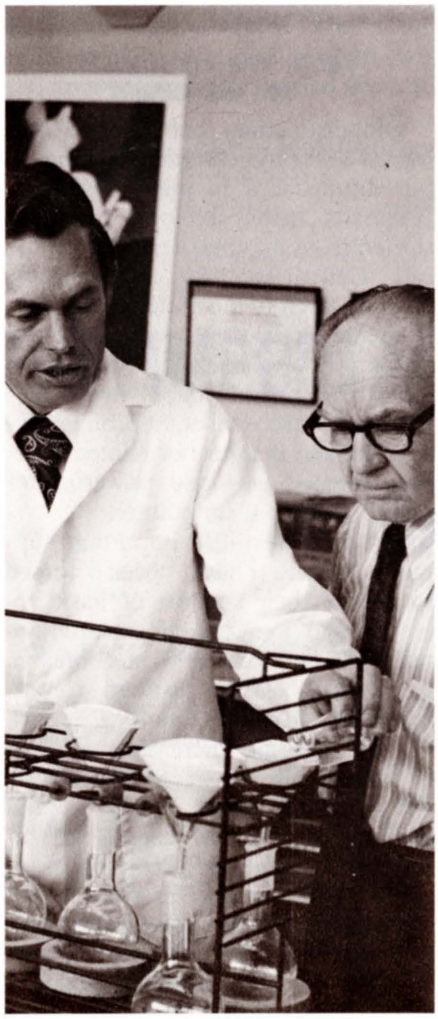
Federal and other important support sources have been forced to reduce their support of basic research and agricultural research interests must step into the breach. This seems easily justified for as mentioned in a recent national report, "It has become increasing difficult to distinguish between agricultural and nonagricultural research, and agricultural research cannot be restricted to empirical comparisons of methods to increase productivity."*

Agricultural research laboratories have supported the work of some of the nation's most outstanding scientists. Despite this, agriculture does not enjoy the prestige that it should in some quarters because it has not taken the lead in basic research that

Agriculture does not enjoy the prestige that it should in some quarters because it has not taken the lead in basic research that is so intimately a part of its mission.

*Report of the Committee on Research Advisory to the U.S. Department of Agriculture. National Research Council. p. 9, 1972.

is so intimately a part of its mission. Important areas that today provide opportunity for, and indeed require, basic research are forest entomology, photosynthesis, nitrogen fixation, toxicoses, genetic control of metabolism, the role of membranes in metabolic control, the fate of food additives, growth response in relation to hormonal control, mechanism of response to insects and diseases, the biochemistry of frost damage, and several aspects of animal nutrition.



Basic research can be justified on its own merits as part of the Experiment Station budget.

CURRENT BASIC RESEARCH

Several basic research programs are now underway in the College of Science and closely related areas. One program, bridging basic and applied research, concerns improvement of cultivated plants through selection for gene types at the level of the individual plant cell. The problem is to select individual cells having desirable characteristics and to eventually produce mature plants from them.

Another program involves the use of embryo transfers to study the compatibility of gene types in animals. Somewhat related work involves investigations in both the field and laboratory of endocrine parameters and the effects of irradiation, temperature, lighting schedules, nutritional factors, seasonal effects, and social stress in reproductive processes. One interdisciplinary study is concerned with substances that have both radioprotective and anticancer properties and their opposites. The purpose of the work is to ascertain how these compounds exert their influence on cells, particularly those involved in the reproductive process. Other research is concerned with the effect of increased ultraviolet radiation intensities on the growth mutation rates, and photosynthesis of agricultural and native plant species, and on insect populations.

One applied research program that supports a considerable amount of basic research concerns the development of new and improved means of making early diagnosis of calf scours. A better vaccine for the treatment of the disease might easily result from this work. Other studies are underway to determine possible bases for chemotherapeutic treatment of mycoplasmal diseases of animals and plants, and still others are employing trout and certain insects to show the effects of environmental pollutants on cells.

The alfalfa weevil causes losses as high as $5,000,000 annually in Utah. While the college's research program on this insect might be considered applied in nature, a considerable amount of basic research has lead to the development of an artificial diet to permit the culture of the weevil in the laboratory under carefully controlled and managed conditions.

Each year many tons of synthetic iron chelates are spread on various

crops in Utah to prevent iron deficiency (chlorosis). The ultimate fate of these compounds is unknown. Research here has revealed that organisms in local soils (one of which is a common plant fungus) are capable of producing natural iron chelating agents for use by higher plants. Since natural iron chelates are not so potentially dangerous to ecosystems, they might well prove to be a better source of agricultural iron supplements. This is an excellent example of National Institute of Health supported research, directly applicable to Utah, which might reasonably be receiving state Experiment Station support.

One of the basic research programs at Utah State University, which has received partial support from the Experiment Station, has potential value in the problem of nitrogen fixation — of great importance to the matter of soil fertility. Work has demonstrated that the molybdenum in enzymes involved with nitrogen metabolism is tied to a protein-like residue that is common to all of these enzymes. This work is of basic biochemical importance, but obviously has a bearing on the important agricultural problem of nitrogen nutrition of plants.

A program in basic research originating with the late Datus M. Hammond,* is concerned with aspects of the development and effects of certain species of protozoa in cattle, rabbits, rodents, carnivores, and chickens and concerns, among other things, immunity in animals.

SUPPORT

Other examples might be given of basic research that is receiving support by the Utah State Experiment Station and the USDA. The quality is impressive, and the record of such support here undoubtedly is good in comparison with other stations. It is interesting in this regard, however, that the support amounts to only about 4 percent of the total experiment station budget.

Our continuing practice should be as policy matter, to identify areas where basic research promises to contribute to the solution of future agricultural problems and to allocate the necessary support. Basic research can be justified on its own merits as part of the Experiment Station budget. Funds to support it should not be hidden among the various allocations to research which are normally allocated on a commodity basis.

Thus far agriculture has been largely dependent on other agencies for its basic research. This position is increasingly difficult to defend, particularly in view of decreasing support now going to those agencies.

The problems in agriculture need investigation at the cell, membrane, and the molecular level, just as do other fields of biology. If experiment stations are to attract young, high quality, energetic scientists who will involve the basic sciences of biology, biochemistry, and physics in an underpinning of agricultural science, there must be provided a real opportunity for basic research. Otherwise the necessary integration of agricultural research with the basic sciences in today's scientific setting will not occur.

Thus far agriculture has been largely dependent on other agencies for its basic research.

*Former professor and head of the Department of Zoology at USU.

UTAH'S Tourism and Recreation Potential

JOHN D. HUNT

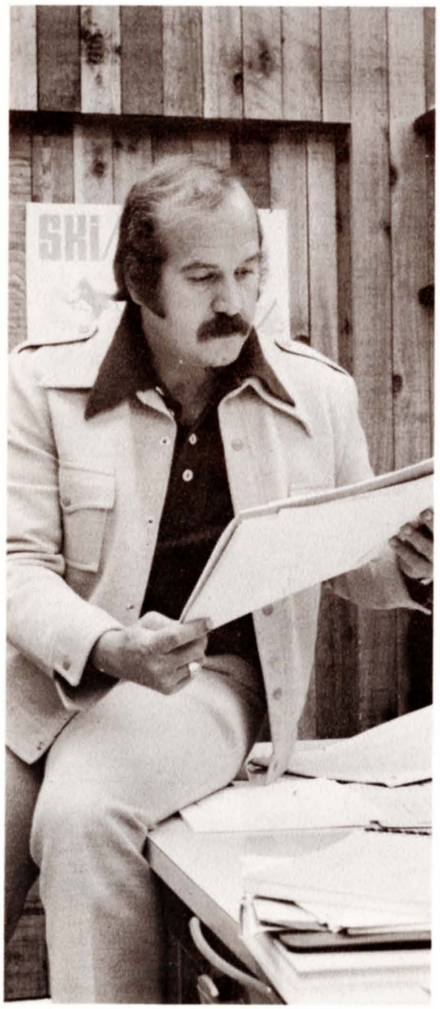
In many parts of the United States the tourism and recreation industry has long been recognized as an important economic development tool. In Utah it has been approached with sporadic attention and considerable apathy. Although state government and some comunities have recognized tourism as a legitimate industry, many areas have done little to give it leadership and a place in economic development plans.

In a time of economic uncertainty, mounting unemployment, and energy scarcity it seems paramount that a state such as Utah take stock of its future. In any such analysis agriculture, tourism, and small industrial development must be given careful and earnest consideration.

Tourism and related recreation expenditures are and will continue to be important to Utah, although some regions of Utah contain greater opportunity for tourism development than others.

Utah State University's Institute for the Study of Outdoor Recreation and Tourism has developed a growing body of pertinent information from which it is possible to make preliminary estimates of the relative importance of tourism to Utah and to regions within the state.

Present estimates indicate that nonresident vacationers who visit and pass through Utah spend approximately $100 million each year in the state. Utah residents spend another



John D. Hunt, assistant dean of the College of Natural Resources and chairman of the Institute for the Study of Recreation and Tourism

Many areas in Utah have done little to give tourism leadership and a place in economic development plans.

$60 million to $70 million outside of their home communities in other regions of the state on recreation related expenditures. These dollars, expanded in the normal economic process, contribute significantly to personal income, tax receipts and the general welfare of Utah citizens.

During the initial period of our recent energy shortage, considerable concern was voiced by travel and recreation leaders concerning the impact of energy conservation upon their industry. It was recognized that the tourism and recreation industry was critical to some regions and restrictions on travel would bode poorly for these areas. With this growing concern came the need to assess the relative importance of tourism among the states.

ASSESSING TOURISM DEPENDENCY

In response to this need, the staff from USU's Institute for the Study of Outdoor Recreation and Tourism developed a simple set of indicators. To assess tourism importance, it was necessary to estimate the size of each state's economy and the amount of tourism and travel expenditures. Using state traveler expenditures from the National Travel Expenditure Study (U.S. Travel Data Center, 1973), 1970 state populations, state per capita personal income, and gross state products (Congressional Record, October 15, 1973), two measures of the relative importance of tourism to a state's economy were developed. One measure compared the per capita amount of money spent for recreation and travel in a state to the state's per capita personal income, suggesting the relative importance of tourism to individual wealth. The second measure was a comparison of total tourist and recreation expenditure in a state to the state's gross product, suggesting the relative importance of tourism to the state's economy.

Because some states have more people, bigger and more diversified industry, and very different size of overall economies, the impact of tourism within the states is likewise different. For example, tourism, recreation, and other travel-related expenditures in California, which total nearly $4 billion annually, are less important to the state's total economy than in Utah where expenditures reach less than $0.4 billion. In California, where there are more people, personal wealth, industry, and a much larger overall economy, tourism represents only a fraction of personal wealth and economic activity.

In the final analysis Nevada is the most tourism dependent state in the United States and Connecticut is the least. More important, however, is the fact that Utah ranks in the top dozen states in tourism dependency.

THE UTAH SITUATION

Utah has two large and sometimes independent tourism-recreation phenomena: the nonresident who visits or passes through the state each year on vacation, who is the primary contributor to its economy, and the Utah resident who engages in myriad recreational activities throughout the state.

Utah ranks in the top dozen states in tourism dependency.

These two types tend to exhibit different characteristics and needs and call for different programs and goals to be adopted by the state and regions' tourism and recreation development. While analysis of both groups is critical for a complete look at Utah's tourism and recreation potential, this article restricts itself to the tourism or nonresident potential. Preparation of the resident recreation analysis is now in progress.

The first issue in Utah's nonresident tourist industry, then, is the relative importance of tourism or the nonresident visitor to the various counties or regions within the state. Coupled with this question must be an identification of regional potential for future development. A host of variables and methods could be used to address these issues; the following analysis is only a beginning. The four variables of tourism dependency, attractional visitation, tourist traffic volume, and skier visits are analyzed in the nine tourism regions (groups of counties) developed by the Utah Division of Travel De-

velopment and used for purposes of travel promotion and development by many organizations. Each region is given a score of nine to one depending upon the relative magnitude of these four variables and an average score is calculated. The higher the tourism dependency factor, number of visits to attractions, volume of tourist traffic passing through, and nonresident skier visitation in a region, the higher the score. The assumption is then made that regions with higher scores presently exhibit greater tourism activity and potential. Admittedly, these factors represent only a crude estimation and future changes in capital investment, highway development, and land use could conceivably cause changes in regional potential. Those areas with extreme scores, however, are most likely to maintain their status regardless of future changes.

TOURISM DEPENDENCY

It is possible to compare the regions in tourism dependency following the same procedure developed to compare the states. Table 1 lists the regions and their per capita personal income, gross nonresident tourism expenditure, per capita tourist expenditure, and resulting tourism impact or dependency factor. The higher the tourism impact factor the more important tourism expenditures are to the personal wealth of the residents in the region.

The data in Table 1 clearly indicate that Color Country, the five county southwestern region, is relatively the most tourism dependent region in Utah. A more detailed examination of the data would show some extremely high county dependencies in this region which are smoothed out in the regional analysis. Kane and Garfield counties have Tourism Impact Factors of 58.3 and 33.9 respectively, when calculated independently. These figures suggest an extremely high tourism dependency in these counties. Anything which would adversely affect tourism in general

Color Country is relatively the most tourism dependent region in Utah.

Table 1. Tourism impact factors for the Utah travel promotion regions

Region	Population[10] (1972)	Per Capita Personal Income	Nonresident Tourist Expenditures[11] (in thousands)	Per Capita Tourist Expenditures	Tourism Impact Factor[12]	Relative Importance Score
Bridgerland[1]	46,500	$2,907	$1,619	$ 34.82	1.2	2
Canyonlands[2]	16,900	3,020	3,745	221.60	7.3	8
Castle Country[3]	21,700	3,489	2,701	124.47	3.6	5
Color Country[4]	39,100	2,794	17,294	442.30	15.8	9
Dinosaurland[5]	24,800	3,535	3,650	147.17	4.4	6
Golden Spike Empire[6]	274,500	3,435	4,251	15.49	0.5	1
Great Salt Lake Country[7]	504,000	4,482	30,347	60.21	1.3	3
Mountainland[8]	162,600	2,728	7,572	46.57	1.7	4
Panoramaland[9]	37,600	2,581	5,478	145.69	5.6	7

[1]Cache and Rich Counties.
[2]Grand and San Juan Counties.
[3]Carbon and Emery Counties.
[4]Beaver, Garfield, Iron, Kane and Washington Counties.
[5]Daggett, Duchesne, and Uintah Counties.
[6]Box Elder, Davis, Morgan and Weber Counties.
[7]Salt Lake and Tooele Counties.
[8]Summit, Wasatch and Utah Counties.
[9]Juab, Millard, Piute, Sanpete, Sevier and Wayne Counties.
[10]Source: Billings, M.A. Selected Business Statistics — Utah Counties. **Uta Economic and Business Review**. University of Utah. 34(3)1-10.
[11]Source: Hunt, J. D., P. J. Brown, and A. Kinzler, Utah Motor Vehicle Travel — 1971-72 and Utah Air Travel —1971-72. Institute for the study of Outdoor Recreation and Tourism, Utah State University.
[12]$\frac{\text{Total tourist expenditure}}{\text{Resident population}}$ = per capita tourist expenditure.
$\frac{\text{Per capita tourist expenditure}}{\text{per capita personal income}} \times 100$ = Tourism Impact Factor.

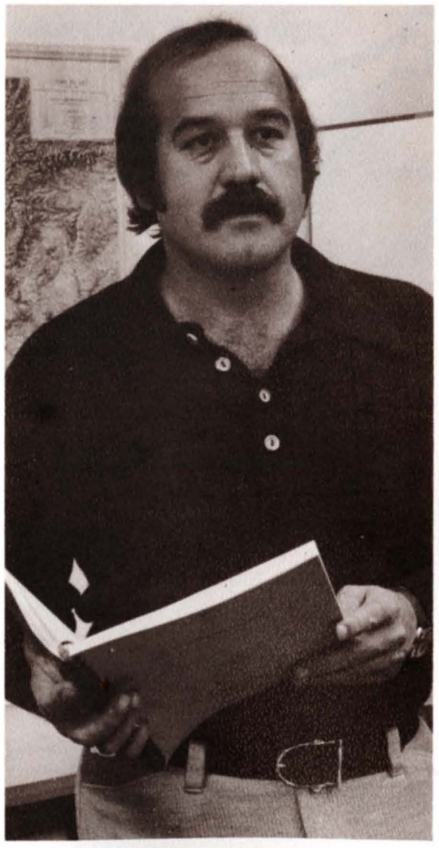
would be most heavily felt in these two counties.

The Canyonlands Region is the second most tourism dependent region in the state. Panoramaland, Dinosaurland, and Castle Country are, relatively, midway in the ranking of tourism dependency.

In the Golden Spike Empire, Bridgerland, Great Salt Lake Country, and Mountainland, essentially the northern half of Utah, tourism is not as significant a part of the personal wealth and overall economy as is the case for other regions of the state. There is one notable exception in the area that deserves special note. Summit County, one of the three in Mountainland, is relatively tourism dependent. It would receive a Tourism Impact Factor of 10.8 if examined independent of Utah and Wasatch Counties.

VISITING ATTRACTIONS

It is, in part, the attractions of a region which yield opportunity for future development. Table 2 shows the percent of nonresidents who visit attractions in each of the regions and places the Great Salt Lake Country and Color Country highest. The Great Salt Lake's location at the crossroads of the Intermountain West undoubtedly contributes to high visitation of its attractions, although it cannot be denied that millions of tourists find Great Salt Lake Country's attractions (Temple Square, The Great Salt Lake, Alta-Snowbird Resort Area and Kennecott Copper Open Pit Mine) interesting and attractive places to visit.



Canyonlands, although lower in attractional visitation than Great Salt Lake Country and Color Country, has a significant number of attractions which appeal to the nonresident visitor.

TOURIST TRAFFIC

The third variable to consider in this analysis is the volume of tourist parties that pass through Utah. Although a region may be receiving only limited tourist activity, if large volumes pass through the area strategies may be developed to encourage them to stop and visit. The higher the volume of tourist traffic the greater is the potential to increase tourist business.

The higher the volume of tourist traffic the greater is the potential to increase tourist business.

Table 3 is an estimate of the number of motor vehicle tourist parties that passed through each travel promotion region in 1971-72. Mountain-

Table 2. Percent of total visits made to Utah attractions in Utah travel promotion region by tourist parties, 1971-72[1]

Region	Percent of Total Visits	Relative Importance Score
Bridgerland	4.8	3
Canyonlands	19.7	7
Castle Country	1.3	1
Color Country	54.6	8
Dinosaurland	13.1	5
Golden Spike Empire	3.6	3
Great Salt Lake Country	69.4	9
Mountainland	13.1	5
Panoramaland	5.2	4

[1]Source: Hunt, J. D., P. J. Brown and A. Kinzler. Utah Motor Vehicle Travel, 1971-72 and Utah Air Travel, 1971-72. Institute for the Study of Outdoor Recreation and Tourism, Utah State University.

land, because of its strategic location, intercepts nearly all tourist parties that travel through Utah. Only those who restrict their travel in the southeastern, southwestern, or northeastern corners of the state miss this area.

SKIER VISITS

The last variable used in this analysis is the number of skier visits by nonresidents (Table 4). Although the ski industry does not reach the magnitude of the summer and fair weather motor vehicle tourist industry it is important to some regions and also affords them the opportunity to achieve a nearly year-round tourist industry. This, in turn, creates a much more healthy industry.

Obviously, the Great Salt Lake Country and Mountainland presently hold the overwhelming appeal to the nonresident skier, followed by Color Country. While other regions are considering future ski area development it is likely that the proximity of the Great Salt Lake Country and Mountainland to Utah's major commercial air transportation and existing ski development there will maintain the popularity of these areas.

WHERE WILL THE TOURISTS GO?

The final step in this analysis involves the calculation of an average relative importance score from Tables 1, 2, 3, and 4. Table 5 lists these scores. Although it is possible to

Table 3. Number of motor vehicle tourist parties passing through Utah travel promotion regions, 1971-72[1]

Region	Number of Parties	Relative Importance Score
Bridgerland	250,000	1
Canyonlands	375,000	4
Castle Country	350,000	3
Color Country	700,000	7
Dinosaurland	325,000	2
Golden Spike Empire	675,000	6
Great Salt Lake Country	925,000	8
Mountainland	1,150,000	9
Panoramaland	575,000	5

[1]Source: Hunt, J. D., P. J. Brown and A. Kinzler. Utah Motor Vehicle Travel, 1971-72. Institute for the Study of Outdoor Recreation and Tourism, Utah State University. The total number of parties passing through regions far exceeds the number of individual parties that visited Utah since many parties passed through more than one region.

Table 4. Nonresident skier visits to ski areas in the Utah travel promotion regions, 1972-73[1]

	Nonresident Skier visits	Relative Importance Score
Bridgerland	7,000	5
Canyonlands	b	0
Castle Country	0	0
Color Country	45,000	7
Dinosaurland	0	0
Golden Spike Empire	10,000	6
Great Salt Lake Country	335,000	9
Mountainland	215,000	8
Panoramaland	b	0

[1]Source: Institute for the Study of Outdoor Recreation and Tourism, Utah State University and ski area operators. Since some operators refused to report this information, in some cases, estimates were generated from U.S. Forst Service data and other sources.
[b]Although there are ski areas in both Canyonlands and Panoramaland their level of nonresident use is insignificant.

To the right — Utah's nine promotional regions

Map, courtesy of the Utah Travel Council

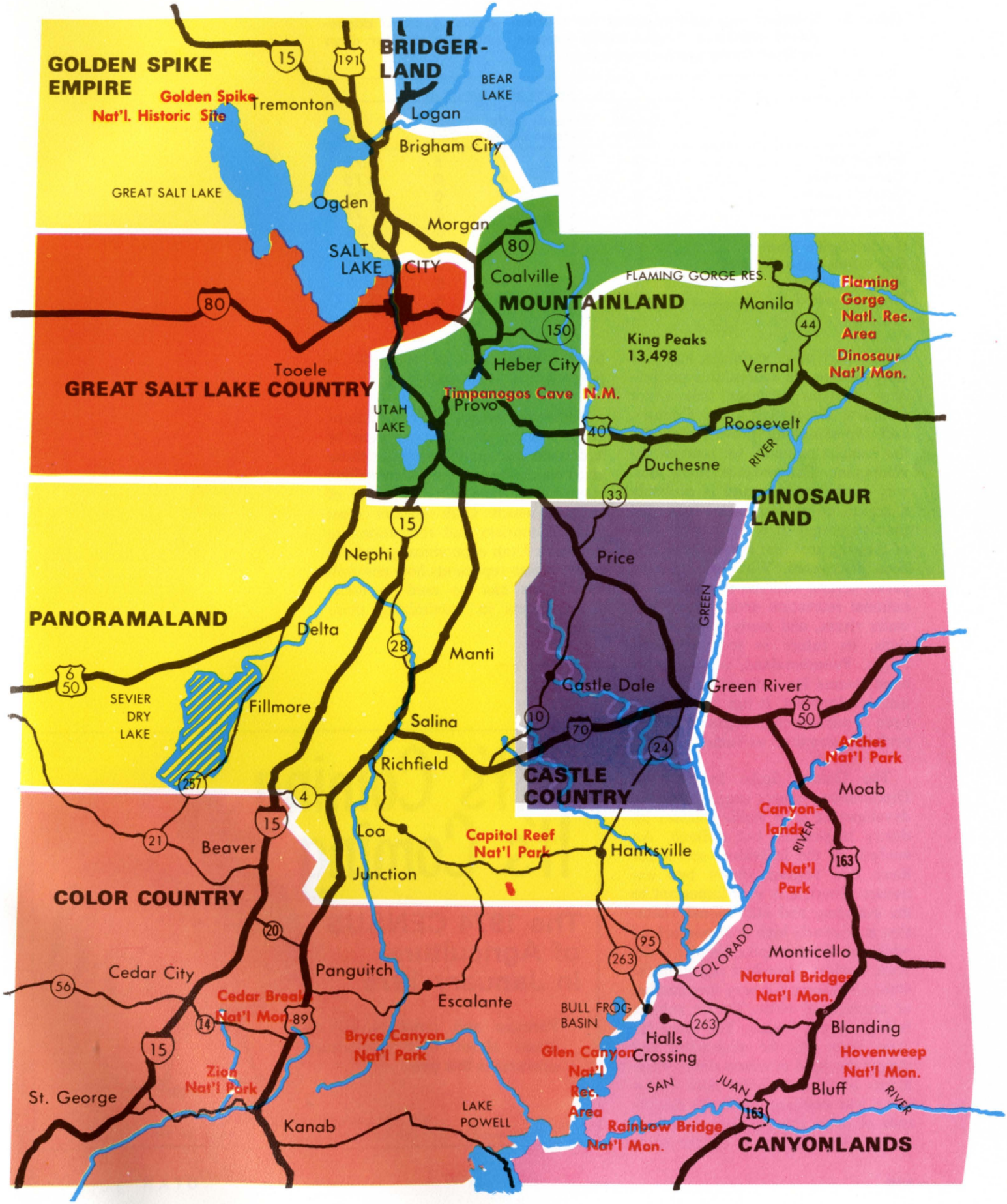

GOLDEN SPIKE EMPIRE
Golden Spike Nat'l. Historic Site
Tremonton
15
191
BRIDGER-LAND
BEAR LAKE
Logan
Brigham City
GREAT SALT LAKE
Ogden
Morgan
80
SALT LAKE CITY
Coalville
MOUNTAINLAND
FLAMING GORGE RES.
Flaming Gorge Natl. Rec. Area
Manila
44
King Peaks 13,498
Vernal
Dinosaur Nat'l Mon.
150
Heber City
Timpanogos Cave N.M.
Provo
UTAH LAKE
Tooele
GREAT SALT LAKE COUNTRY
40
Roosevelt
RIVER
Duchesne
33
DINOSAUR LAND
15
Nephi
Price
GREEN
PANORAMALAND
Delta
28
Manti
6
50
SEVIER DRY LAKE
Fillmore
Castle Dale
Green River
10
70
24
Salina
Arches Nat'l Park
Richfield
CASTLE COUNTRY
Moab
257
4
15
Canyon-lands Nat'l Park
RIVER
21
Beaver
Loa
Capitol Reef Nat'l Park
Hanksville
163
Junction
COLOR COUNTRY
20
95
263
COLORADO
Monticello
Cedar City
Panguitch
Natural Bridges Nat'l Mon.
56
Cedar Break Nat'l Mon.
Escalante
BULL FROG BASIN
14
89
263
Blanding
Halls Crossing
15
Bryce Canyon Nat'l Park
Glen Canyon Nat'l Rec. Area
Hovenweep Nat'l Mon.
Zion Nat'l Park
SAN JUAN
Bluff
RIVER
St. George
LAKE POWELL
163
Kanab
Rainbow Bridge Nat'l Mon.
CANYONLANDS

Table 5. Relative importance scores for tourism impact factors, attractional visitation, tourist traffic volume, and tourist skier days for Utah travel promotion regions.

Region	Relative Importance Score				
	Tourism Impact Factor	Attraction Visitation	Traffic Volume	Skier Days	Average
Bridgerland	2	3	1	5	2.75
Canyonlands	8	7	4	0	4.75
Castle Country	5	1	3	0	2.25
Color Country	9	8	7	7	7.75
Dinosaurland	6	5	2	0	3.25
Golden Spike Empire	1	2	6	6	3.75
Great Salt Lake Country	3	9	8	9	7.25
Mountainland	4	5	9	8	6.50
Panoramaland	7	4	5	0	4.00

study many more variables, and possibly change the scores, this preliminary analysis suggests that Color Country, Great Salt Lake Country, and Mountainland presently exhibit the greatest potential for tourism development. Canyonlands rates midway in the ranking and is probably a region of greater future potential than suggested. It is a relatively out-of-the-way area that has only recently been discovered. With two national parks, several national monuments, a national recreation area, three white water rivers, and many other attractions, its future in tourism seems bright. Panoramaland, on the other hand, seems less attractive for tourism development. It has traditionally been a pass-through region and will probably continue as such.

The Golden Spike Empire and Dinosaurland scores suggest that the development of a viable tourism industry is possible but difficult. An analysis of the individual scores for these two regions shows two extremes. Tourism is very important to the economy and attractional visitation is relatively high in Dinosaurland while the Golden Spike Empire is the least tourism dependent region in the state and receives a very low number of attractional visits. Traffic volume is high in this region. The score for skier visits may be misleading and distort the final outcome since, while it gets some nonresident skier use, it in no way compares with the magnitude of other skier regions. Unfortunately, Dinosaurland is off the main travel routes of tourists and is plagued by severe seasonality.

Although many other questions about tourism development must be addressed this analysis suggests those areas which should receive immediate attention. It represents the kind of analysis which Utah leaders must make if tourism and recreation are to benefit Utah economically and socially. It also represents how research information can be used to assist these leaders in maximizing these benefits.